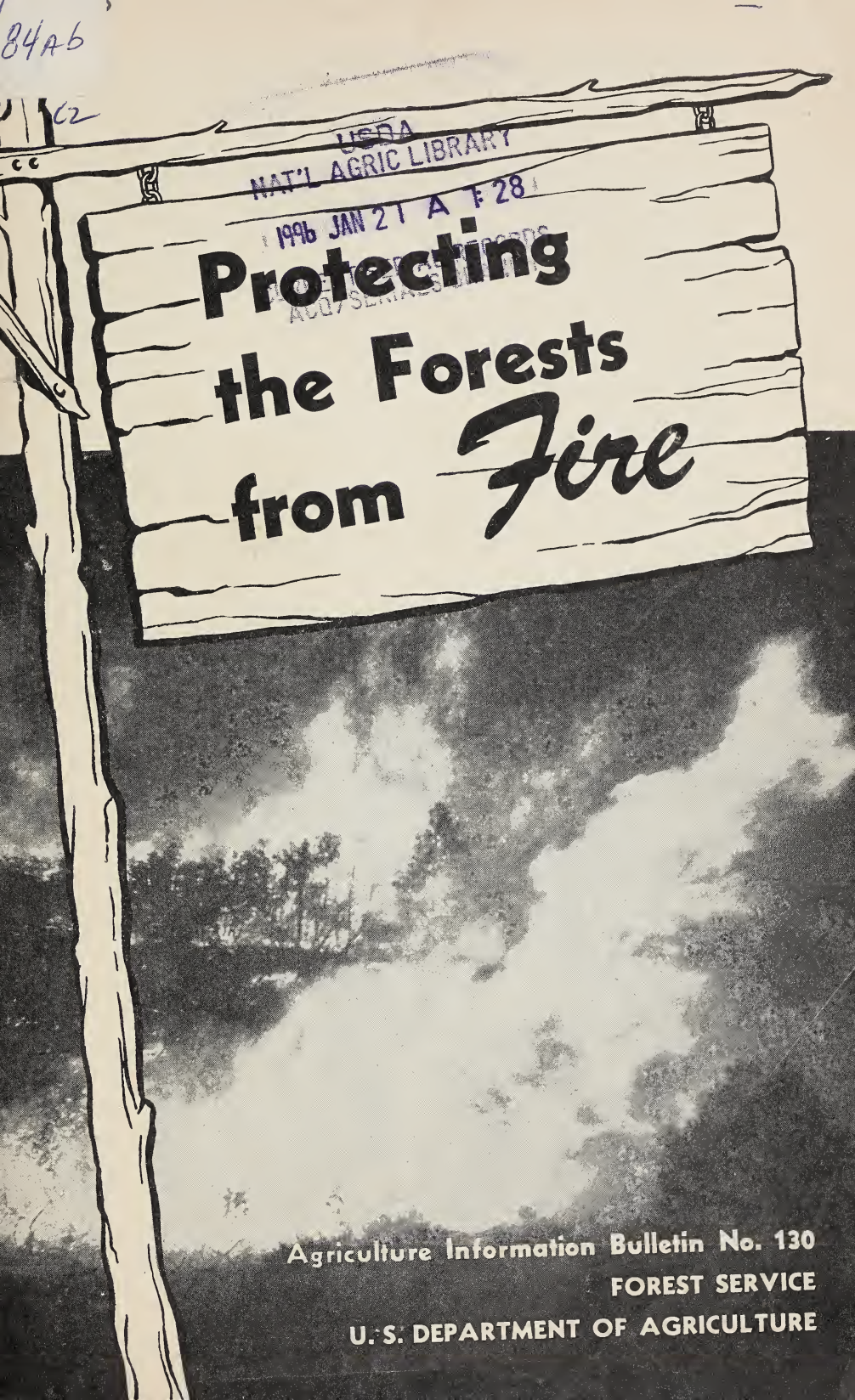
Protecting the Forests from *Fire*



Agriculture Information Bulletin No. 130
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

PROTECTING THE FORESTS FROM FIRE

Contents

LOSSES—TANGIBLE AND INTANGIBLE

In the decade that ended in 1950, more than 1,824,000 forest fires occurred in the United States. They occurred at the rate of about 500 per day. They burned over an average of 21,622,000 acres each year, an area larger than the State of Maine. They caused direct damage to timber and property estimated at $392,000,000. They took scores of human lives.

The great majority of forest fires, especially in the East and South, are "surface fires," burning mostly in the duff or leaf litter on the forest floor. Promptly attacked with adequate manpower and equipment, such fires are fairly easy to control. But nearly every small forest fire is potentially a big one. If a combination of dry weather and high winds occurs, a forest fire may spread with explosive violence, roaring through the trees faster than a man can run, generating waves of heat and gas that fan the flames to even greater fury. A really bad forest fire is a terrifying thing. It will destroy nearly everything in its path.

That was what happened when the Peshtigo fire in Wisconsin in 1871 wiped out whole settlements and killed 1,500 persons; when the great Idaho fires of 1910 wiped out several million acres of virgin timber in a few days. It happened when the Tillamook fire in Oregon in 1933 killed as much timber as was cut in the entire United States the preceding year. It happened in Maine in 1947 when forest fires destroyed more than 800 homes. It can happen again. Given the right combination of weather and fuels, big and destructive forest fires are still possible in many parts of the United States.

A surface fire, consuming the dry leaves, grass, twigs, and underbrush on the forest floor, may not kill outright many of the larger trees, but it will kill seedlings and small trees (fig. 1). Most fires start as surface fires but may develop into other types.

Sometimes fires burn deep below the surface in the thick duff of decayed leaves or needles, or in muck soils that have become dry. Giving off very little smoke between surface outbreaks, such "ground fires" may smolder for days or weeks before being discovered, and it

Issued December 1954
Washington, D. C. Slightly revised October 1958

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FIGURE 1.—Surface fires such as this one burning the litter in a hardwood stand kill the seedlings and saplings and damage the larger trees.

is difficult to know when they may safely be declared out. Ground fires are common in northern forest regions. These fires usually kill most of the trees in their way, for although they burn slowly they generate great heat beneath the surface.

It is usually the "crown fire," or combined surface and crown fire, that causes the greatest timber and property damage, and loss of human life. Such a fire is usually the outgrowth of a surface fire which, driven by a strong wind, leaps into the tree tops and sweeps through the timber (fig. 2), often even jumping across open fields or large rivers. Crown fires occur mostly in coniferous forests, for the green leaves of hardwoods (broad-leaved trees) are not easily ignited. These fires may, however, run through forests of mixed hardwoods and conifers. Usually they create showers of flying embers which set fires far in advance. Crown fires may kill all the trees over wide areas; they may destroy farm homes and villages.

Losses of merchantable timber and property are direct, tangible, and readily apparent. Forest fires, however, cause many damages not so easily recognized. Fire may kill the tiny young trees in a forest and so destroy the mature timber crop of 20, 50, or 100 years hence. Fire may alter the character of a forest. As a result of fire, for example, a forest in which valuable pines or spruces predominated may in time become mostly a scrubby growth of inferior species. Repeated fires have turned many millions of acres of forest land in the United States into unproductive wasteland.

F-223907

FIGURE 2.—Crown fires are devastating.

Even a small, smoldering surface fire may leave fire scars on the trunks of trees, where wood rots may enter. Fire-weakened trees may be attacked by insects, or more easily felled by the wind. A woodland owner thus may suffer losses in his cash-crop trees, even through the fire actually kills very few of them.

Fires destroy valuable forage on western ranges. When rangeland burns over, ranchers often are forced to find other feed for their livestock for many months. And exposure of the soil when grass and brush is burned may cause erosion and floods.

Storm runoff is greatly accelerated when fires burn the vegetation and surface litter on steep slopes. A flood that caused $347,000 worth of damage in Salt Lake City in 1945 came directly from a 600-acre burned area on the grass-and-brush-covered hills north of the city. The Montrose, Calif., flood of 1934, that caused $5 million damage and took 34 lives, came from a watershed area that had been burned about a month earlier. Damaging floods similarly followed fire on the watershed area near Los Angeles in 1954. Following the big Columbia River flood of 1948, watershed technicians found ample evidence that much water would have been held back until after the

flood peaks had passed and damage would have been less if millions of acres in the upland watersheds had not been depleted of their plant and forest cover, mainly by forest fires.

Fires have impaired the ability of watersheds in many parts of the United States to absorb rainfall and hold back runoff (fig. 3). Along with unwise land clearing and other watershed abuses, fire is responsible for a vast amount of flood damage, for aggravated problems of water supply, and for the silting of reservoirs, stream channels, and harbors with millions of tons of sediment eroded from the land.

Forest fires kill many game animals and birds. Wood ashes washed into streams after a fire sometimes kill large numbers of fish. Destruction of the vegetation along streambanks may cause water temperatures to rise and make the stream unfit for trout. Sedimentation from fire-damaged watersheds has ruined many good fishing streams.

Forest fires can hurt tourist and recreation business. Vacationers are not likely to visit areas where the scenery has been blacked by flames.

Many railroad lines, highways, and telephone and telegraph lines pass through forest areas, and fires can therefore disrupt business communications and railroad and truck transportation.

F-460695

FIGURE 3.—Violent, silt-laden runoff is the threat from this watershed which has had its litter and vegetation burned off.

Losses such as these, and many other indirect and intangible losses caused by forest fires, are not easily measured in dollars. But in the aggregate they represent a huge drain on the resources and manpower of the Nation. To the losses caused by fires must be added the costs of controlling them, to keep the damages from mounting to an even greater total.

A COMPLEX PROBLEM

In few parts of the world is the problem of keeping the forests from burning as complex and difficult as it is in the United States. In this country there are many regional variations in terrain, types of vegetation, and seasons of greatest fire danger. The normal fire seasons in the forests of the Eastern and Central States are spring and fall. In early spring, soon after the snows have melted and before the deciduous trees have leaved out, a few days of sun and wind can dry out the forest litter and create a high fire hazard. After the leaves fall from the trees in autumn, the forest floor is again exposed to sun and wind, and the dry, new fallen leaves are added fuel. The fire season may extend through the winter months in the Deep South. In the Western States, most of the forests are in the mountainous areas, and these higher elevations are apt to be covered with heavy snows throughout the winter. The dry summer months are normally the period of greatest forest fire danger.

Changes in fuels, weather, or degree of exposure to sources of fire can alter the situation locally or regionally. Prolonged droughts may bring periods of danger during the summer months in portions of the East, or delayed snows may mean that the fire season extends into the winter. A few years ago, foresters had to fight a brush fire in northern California when there was several inches of snow on the ground.

Even within a normal fire season, forest fire danger fluctuates widely. A fire-control organization must be geared to meet a threat which today may be half what it was yesterday, but may jump to a hundred times that of today by next week. New activities in an area may alter the fire problem. Changes in the character of a forest or range—in species of plants, in growth or decay—have their effects.

The forest fire hazard has increased in recent years throughout much of the West. Epidemic attacks by insects have killed timber over large areas in Colorado, Montana, Idaho, and Wyoming. In the bug-killed timber—in some places a tangled mass of fallen trees—fires can burn hot and spread fast. Heavy accumulations of logging slash intensify fire-control problems in many western forests. And increased industrial and recreational use of the forests means greater numbers of people in and near the forests who might start fires.

CAUSES OF FOREST FIRES

Most forest fires are caused by human carelessness, negligence, or ignorance. Forest fire prevention, therefore, is mainly a problem of improving people's ways, of creating a better understanding of the importance of forests, an awareness of the danger of fire in the woods, and a sense of personal responsibility on the part of every citizen to safeguard the forests from damage. That is not an easy job. A city dweller used to paved streets, for example, does not easily change his smoking habits when he goes into the woods.

During the 3-year period 1955 through 1957, the causes of fires reported on protected forest and watershed lands of the United States were as follows:

Cause:	*Percent*
Incendiary	26
Debris burning	24
Smokers	19
Lightning	10
Campers	4
Railroads	3
Lumbering	2
Miscellaneous or unknown	12

Incendiarism, the leading cause of forest fires, is a problem mainly in the South. Some 80 percent of the forest fires of incendiary origin reported on protected lands are in the Southern States. Persons sometimes start forest fires deliberately to spite a neighbor, to obliterate evidence of a misdeed, or because of a grudge against public authorities. Children, and sometimes adults with immature minds, may set fires in the woods for the excitement of it. But comparatively few man-caused forest fires are set maliciously.

Annual woods-burning has long been a tradition in many rural sections of the South. The woods are fired every spring to "green up the grass," to get rid of underbrush, or because of mistaken notions that ticks or boll weevils can be eliminated by woods-burning. Any benefits, real or fancied, from such yearly promiscuous woods-burning are usually more than offset by the damages to timber and watershed values. Ideas and customs of long standing will have to be changed before this kind of woods-firing can be wholly eliminated. The problem is one of education, coupled with better fire laws and stricter law enforcement.

Debris burning causes many fires in farm woodlands. Too frequently, fires started by landowners to burn trash or get rid of brush or weeds get out of hand and spread to the woods. A number of the States still lack effective laws to foster safe practices in the burning of debris. Burning off weeds from fields or clearing "new ground" by burning frequently destroys much organic matter that might better be plowed into the soil.

Careless smokers are responsible for thousands of forest fires each year. Many of these are started when people toss cigarette butts or matches from automobiles traveling in forested areas (fig. 4). Others

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FIGURE 4.—Discarded cigarette ignites pine needles.

are caused by hikers, hunters, fishermen, or woods workers who are careless in disposing of their smoking materials. The Forest Service has posted rules in many of the national forests that prohibit smoking except at improved campgrounds and other designated safe areas. Many of the States now have laws against throwing lighted materials from automobiles. Smoker-caused forest fires will be wholly eliminated, however, only when millions of smokers have become fire conscious and have developed the will to improve their smoking habits.

Campers and picnickers who build campfires in unsafe places or who abandon their still-burning campfires are another cause of forest fires. A smoldering campfire can be fanned into flame again if the wind rises, and its sparks may quickly ignite the surrounding woods. Educational efforts to induce campers to douse their campfires thoroughly with water before they leave them, and prosecution of persons responsible for forest fires through negligence with campfires, are reducing the number of fires from this cause.

Railroad operations formerly caused many more forest fires than they have in recent years. Improved spark arresters and ashpans on locomotives and the conversion to electric and diesel locomotives have reduced the danger from sparks. Many railroad companies now clear and patrol their rights-of-way through forest areas and otherwise cooperate with State and Federal forest protection agencies. The percentage of fires resulting from logging operations also is lower than it was a few decades ago. Many timbermen provide intensive protection on their holdings. Most logging crews observe strict safety precautions; and when bad fires do occur they are usually among the first reserves to be called. They are often the most effective fire fighters. But many industrial fires still occur, and the great damage they frequently do calls for stronger efforts to eliminate them.

Many miscellaneous causes of forest fires have been reported. A few were freak natural causes, such as meteorites, but most of them were the result of human activity. All told, more than 90 percent of all forest fires are man caused, and therefore preventable.

The only important natural and unpreventable cause is lightning, which accounted for nearly 10 percent of the reported fires on protected lands, nationwide, in 1955–57. In the Western States, lightning causes a much higher percentage of forest fires than it does in the East. Of a total of 35,113 forest fires in 1955–57 in the Rocky Mountain and Pacific Coast States, 18,857, or about 54 percent, were lightning caused.

Summer lightning storms in the western mountain regions often occur with little or no rain. In the northern Rockies and Pacific coast regions, large numbers of fires may be started by a single storm (fig. 5): in the national forests of northern Idaho and western Montana in 1953, Forest Service regional headquarters reported more than 1,100 lightning-caused fires in a 20-day period. Forest fires started by lightning are usually tough to handle: they often occur in rugged, high-country areas difficult to reach and difficult to work in.

Nobody yet knows how to prevent lightning from striking. But advances in knowledge of fire weather are helping forest protection forces to know when to be on the alert for lightning-caused fires. Adequate and well-equipped forces can control them quickly and hold the damage to a minimum. And recent experiments in "seeding" thunder clouds to cause precipitation have given at least some indication that it might eventually be possible to prevent or control the lightning itself.

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FIGURE 5.—Lightning storm over a forested area in the Northwest.

BENEFICIAL USES OF FIRE

Under certain circumstances, fire can be a useful tool in the forests, if carefully applied and controlled. Research has worked out practicable techniques for using fire to control sagebrush on certain types of western range where topography is not too rough, and thus to aid the natural comeback of desirable forage grasses, or to prepare the ground for artificial reseeding to grasses. In the southern pine region, foresters are using prescribed burning to aid the regeneration of longleaf pine when heavy growth of broomsedge or other ground cover interferes with natural reseeding. Fire, when properly timed, has been found to help control the brown-spot disease of longleaf pine. Prescribed burning can sometimes be used to get rid of undesired plants and trees, or to remove heavy accumulations of flammable ground cover and thus reduce the hazard of destructive wildfire. In the Northwest, broadcast burning at a safe season is often used to get rid of accumulations of logging slash or debris. Such uses of fire, however, should never be attempted except under the direction of experts. Every safeguard must be taken to make sure the fire is confined to the area prescribed for burning.

A great deal more research in this field is needed. But the fact that fire can at times be used beneficially must never be used to condone uncontrolled wildfire in the woods. Because of fire's great potential destructiveness, constant effort to prevent and control wildfire in the forests is a "must."

HOW FOREST FIRES ARE CONTROLLED

The protection of the forests from fire involves three general phases of activity—prevention, preparedness, and suppression.

Prevention

Foresters often say that "the best way to stop a fire is never to let it start." Since nine-tenths of all forest fires are man caused, and therefore preventable, the U. S. Forest Service, the State forestry departments, the forest industries, and various conservation organizations for many years have conducted educational programs aimed at fire prevention. Educational work through newspapers and magazines, motion pictures and colored slides, lectures and informal talks, radio programs, printed literature, exhibits, and posters has been carried on in an attempt to make people fire-prevention conscious before they reach the woods.

Special fire-prevention clauses are usually included in national-forest timber sale agreements and free-use permits. During periods of extreme drought and high fire danger, certain areas of State and private lands and national forests are sometimes closed to entry by the public. Hunting and fishing seasons may be suspended, and logging operations closed down, because of hazardous fire weather. Patrols of roads, trails, and forest recreational centers also are maintained during periods of high fire danger for the purpose of warning persons using the forests of the great need for care with fire, as well as to supplement the work of the detection and suppression forces.

Spark arresters on railroad and logging equipment, "no-smoking-on-the-job" rules in logging operations, and other safety appliances and rules are prevention measures. Cleanup of logging slash, rubbish, and other flammable debris helps to reduce fire hazards. Strict enforcement of Federal and State forest fire laws aids in prevention.

Since 1942, a special nationwide campaign has been conducted each year to obtain greater public cooperation in the prevention of forest fires. It is now known as the Cooperative Forest Fire Prevention Campaign, officially sponsored by the State Foresters of 45 States and the U. S. Forest Service. This campaign has continued each year with the active support of the advertising industry, through its Advertising Council, Inc., and the cooperation of many other organizations and individuals. The Post Office Department and other Federal agencies have helped greatly in displaying fire prevention posters to the public. The American Red Cross, Boy Scouts, Girl Scouts, thousands of schoolteachers, and many others are strong supporters. American business, through the Advertising Council, contributes about 10 million dollars a year in free advertising space, time, and talent. This represents the support of advertisers, advertising agencies, and newspapers, and of the radio, television, and motion-picture industries.

A 1945 campaign poster showed a bear dousing a campfire with a bucket of water. "Smokey," as the bear was called, seemed to catch the public fancy, and since 1947 each year's campaign poster has featured the fire prevention bear. In 1950, a bear cub, rescued from a forest fire in New Mexico, was named after the fire-prevention poster's Smokey, and his story was carried in newspapers and on radio and television from coast to coast (fig. 6).

Localized campaigns conducted by various groups, and the extensive and growing fire prevention efforts carried on directly by State forestry agencies supplement the nationwide campaign. "Keep Green" programs sponsored by the forest-products industries have

FIGURE 6.—This appealing cub found a place in the hearts of America's children and grownups alike.

been organized in all of the States, and provide for educational and publicity efforts on a statewide basis.

Certainly as a result of these educational efforts, the American public has seen and heard more about forest fire prevention than ever before. Just how many fires have been prevented by these campaigns is impossible to determine. Undoubtedly, however, they were responsible in no small measure for the fact that the number of fires averaged over 70,000 a year less during the 3-year period 1955–57 than in the years before World War II. This reduction occurred in spite of increases in registrations in national forests and parks, in sale of hunting and fishing licenses, in motor travel, and in other factors which indicate that public use of forests and outdoor areas has increased substantially in the postwar years.

Prevention of man-caused fires ultimately depends upon public cooperation. When every person can be made to understand the values of forests, their great susceptibility to fire damage, and his personal responsibility in preventing fires, the problem of man-caused fires will be solved.

Preparedness

Preparedness calls for building up, placing, and training an effective fire-control organization. Adequate fire-control plans must be prepared, covering detection, communication, and all other phases of control. The necessary tools and equipment must be provided and they must be so located and kept in such condition that they are "ready to go." Weather forecasting service, provisions for regularly measuring fire danger, and other technical services must be arranged. Many other things are involved in what is often called "presuppression"—the job of getting ready to control forest fires.

Locating a fire in its early stages is of utmost importance to successful fire control. A good detection system usually consists of a network of permanently established lookout stations on mountain peaks and lesser highlands. During normal fire weather the detection points that give the most complete observation coverage of the surrounding territory are manned. These stations are known as primary lookouts. When the fire danger is extremely high, secondary lookouts or intermediate detection points which afford additional observation coverage for the more hazardous areas may also be manned.

In mountainous country an atmospheric haze condition often occurs which reduces lookout visibility range, making it difficult to detect a fire while it is still small. To offset this, guards are often employed for foot or horse patrol on trails and in exceptionally hazardous areas. Recreational use areas, logging operations, and other special risk areas also are often covered by patrol. The patrolmen, in addition to supplementing the regular detection work of the lookout system, are often the "shock troops" of the suppression forces, as they stop to fight any fire they find on their patrol routes.

Detection of fires from the air by regularly scheduled airplane patrols has proved feasible in several roadless timberland areas of the Northwestern and Lake States. It is most successful where lightning-caused fires are the principal problem, and where a few key lookout stations are retained to supplement the air patrol and to act as radio communication hubs. Regular air detection systems have been used by many of the States, and in all forest regions of the country airplane patrols are often used for supplemental or emergency detection when the danger of fires is unusually high or when haze or a smoke blanket from existing fires in the locality limits the visibility from ground lookouts.

Lookout towers or stations are equipped with telephone communication and in some regions with shortwave radio as well. The station also contains a fire finder for use in accurately locating a fire whose smoke is visible. One kind of fire finder, used at many stations, has two sighting arms with front sight containing a cross-hair for accuracy in sighting on a smoke column. It is mounted on a map table which has been oriented so that the map directions agree with the compass direction on the ground. The rim of the map table is marked off in azimuths or the degrees of a circle, starting with 0 at north and returning there at 360 degrees.

When the lookout man discovers a smoke, he immediately sights his fire finder at it and records the azimuth and distance from his station, together with other landmarks and location data which he can furnish from his map and his knowledge of the country. All of this information he telephones to the district ranger or central dispatcher.

Upon receiving a lookout's report on a smoke, the dispatcher obtains, if possible, other readings on the fire from other lookout stations and then plots the azimuth readings on his map. The intersection of the plotted lines-of-sight gives the exact location of the fire on the map (fig. 7). The dispatcher, as soon as he has the necessary information regarding the location, size, and spread of the fire, and the fuel type in which it is burning, dispatches the initial suppression crew with proper instructions.

In the more heavily populated sections, considerable detection aid is rendered by local residents and passing motorists who report fires they have seen.

F-451383

FIGURE 7.—This towerman, using a dispatcher's map, reports the location of a fire that has been sighted from two towers.

Suppression

In suppression of forest fires the following are of first importance: (1) quick arrival at the fire; (2) an adequate force; (3) proper equipment; (4) a thorough organization of the fighting crew; and (5) skill in attacking and fighting fire. A small fire usually can be put out by 1 to 5 men. Large fires may require several hundred to a thousand or more men and take several days to control and mop up.

No two forest fires are exactly alike. Fuel types, weather, slope and exposure of terrain, accessibility, etc., vary so much that each fire presents an individual suppression problem. The suppression technique adopted by a fire boss on any fire will be based upon his experience and knowledge of fire behavior, but it will usually be an adaptation of one or more of the generally accepted methods of fire

fighting. Two general suppression methods are known as "direct" and "indirect" attack.

Direct attack, or work directly on the burning edge of the fire, may be used only on fires where the rate of spread is slow and the heat is not too great. It may be accomplished by shoveling, raking, or sweeping burning litter back into the fire; beating out flames with wet sacks, specially designed swatters, or green branches; or by using water.

Indirect attack involves work at some distance from the burning edge of the fire. It involves the construction of firelines or the use of existing barriers as lines where the spread can be stopped. It is used on hot, fast-spreading fires which require attack at a distance to provide the necessary workable conditions and time to get a barrier around the fire.

Roads, railroad grades, bare rock ledges, streams, lakes, etc., may provide natural barriers to the spread of a fire, or it may be necessary for the suppression crew, upon arrival at a fire, to construct a special barrier called a fireline or control line around the blaze, so as to confine the fire to the smallest possible area.

In constructing a control line, fire fighters cut away the brush, logs, and small trees where the line is to be located, then the burnable litter is dug or scraped from a strip a foot or more in width to prevent the spread of the fire on the ground (fig. 8). Any snags or dead trees that might throw sparks across the line must be felled.

Whenever water is available it can be used effectively with either the direct or indirect methods of fire suppression attack. Fire-control plans, however, can seldom be based entirely on the use of

F-390022

FIGURE 8.—A fireline is scraped down to mineral soil.

water, as in many parts of the country water may be scarce or entirely lacking near a fire.

Backfiring is an excellent fire-control tool when used by a person of experience, but it can easily "backfire" on the user, with disastrous results, if he is unfamiliar with its uses. Trained fire organizations use backfiring effectively, basing their operations on a control line cleared and dug well ahead of the fire. A road, trail, stream, or other natural barrier also is often used. With a crew patrolling this line to prevent the fire from jumping it, a man selected for his judgment and experience sets fire along this line and the backfire is allowed to burn back to the main fire. This removes combustible fuels and widens the control line. If a wider control line is desired and time permits, a second line of fire may be set and allowed to burn out between two dug lines. When the oncoming fire approaches the backfired control line, it will die from lack of fuel. Unburned corners inside the control line may also be burned out during mopup work to prevent later flareups which might result in the fire getting across the control line.

Rapid transportation and communication are of the utmost importance in fire suppression. To facilitate quick transportation of men and supplies, Federal, State, and private fire protection agencies have built roads, trails, and emergency airplane landing fields in many forested areas. But in some sections of the country there still remain vast roadless areas in which it is necessary for suppression crews not only to walk long distances to a fire but also to carry necessary tools, equipment, and food on their backs. Therefore, forest protection agencies have in recent years used aircraft for the delivery of both men and equipment to remote areas.

ADVANCES IN FIRE-FIGHTING METHODS AND EQUIPMENT

In earlier days, forest fires were put out by main strength and awkwardness—if at all. Fire fighters relied mainly on axes, shovels, and other handtools. Water was carried in pails and used only when immediately accessible to a fire. Although there is still need for much handwork on nearly every fire, fire fighting is becoming more and more mechanized. Many machines and machine techniques for use in fire suppression have been developed in recent years by forest protection agencies.

Transportation equipment has been vastly improved. Where once the mule string or pack train was the only means of moving equipment and supplies into back country, the airplane, special trucks, "jeeps," and "trail scooters" now carry a large share of the load.

Use of aircraft has been a big help in implementing a "hit-'em-fast-and-hard" policy of forest fire suppression. With the cooperation of the Army Air Force, the Forest Service experimented with the use of airplanes for fire detection as early as 1919. By 1930, airplanes were being used by the Forest Service in varying degrees in national forests throughout the West and in the Lake States, and by several of the State forestry departments. Their principal use at this time was for reconnaissance of fires in progress and for detection of fires immediately after lightning storms.

Emergency transportation of supplies has become one of the major roles of aircraft in fire control in recent years. During the 1930's the Forest Service developed successful techniques for delivering sup-

plies by parachute to fire crews in remote areas (fig. 9). A simple, low-cost, homemade parachute was designed. Now many tons of cargo are parachuted to fire crews in an average year.

In Canada and in our Lake States, "bush pilots" use airplanes equipped with pontoons for transportation of men and supplies to fires in the lake country.

F-469561

FIGURE 9.—Fire-fighting equipment dropping toward target laid out by crew already on the ground.

Smokejumpers

At the time it developed successful cargo-dropping techniques, the Forest Service also began thinking about the possibility of parachuting men to fires in inaccessible country. Experiments in jumping were conducted in 1939. The tests proved that men could land safely in rough, forested terrain. Using techniques developed through these tests, the Forest Service in 1940 trained 16 fire fighters who volunteered for parachute jumping. Additional experimental work was planned, but before the season ended, the men were making practical rather

than test jumps, parachuting to fires in inaccessible territory, and promptly controlling them.

The smokejumpers wore specially designed helmets, masks, and protective clothing. Each carried a rope to let himself down if his parachute lodged in a tree. A special type of parachute was developed, designed for slow descent with minimum oscillation, and equipped with steering slots that enabled a jumper to land within a short distance of his goal (fig. 10). After a man jumped, his fire-fighting pack (containing tools, rations, water canteen, first-aid kit, etc.) was parachuted to him. Military staff officers visited the smokejumper training camp in 1940, and many of the Forest Service ideas and techniques were later employed in organizing the first Army paratroop training at Fort Benning, Ga.

Since 1940, smokejumper operations have been conducted by the Forest Service every year in certain sections of the West. The men are carefully selected and thoroughly trained before the beginning of each fire season. By the use of smokejumper crews, fires in remote areas can be attacked soon after discovery, whereas ground crews would require many hours to reach them. Hundreds of fires have been quickly controlled by the parachuting fire fighters, fires that

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FIGURE 10.—Smokejumper preparing to land as he guides his chute by pulling on risers to operate steering slots.

otherwise would have spread to burn large areas and cause great damage.

The Forest Service smokejumper corps each year now numbers about 300 men. Crews are assigned to the national forests of Montana, Idaho, Washington, and Oregon. The Oregon crew also operates across the line in northern California. A small crew also is assigned to New Mexico early in the season. In the first 10 years of smokejumper operations (1940–49) the men jumped to a total of 1,424 fires. Estimated savings amounted to more than $2 million.

The Forest Service has worked continually on the improvement of existing equipment and the development of new equipment to increase the efficiency and safety of aerial fire control operations. Parachutes and parachute packing methods used for dropping fire-fighting equipment and supplies have been improved to reduce opening and landing shock, reduce oscillation, and prevent parachutes and cargo from damaging or catching on the tail surfaces of aircraft. Steerable parachutes used by smokejumpers have been improved to increase their forward speed. This permits landing under more adverse wind conditions.

Helicopters

In 1945, the Army and the Forest Service joined in a series of tests with helicopters under western forest conditions. These and the tests of commercial helicopters that followed proved the value of this type of aircraft in forest fire control work. With its ability to maneuver, fly at slow speeds, and hover, it can enable observers to note the behavior of a fire and the type of ground cover in detail, and quickly make accurate plans to combat the fire (fig. 11). Helicopters can be used to transport key men to a fire quickly, to deliver men to fires in isolated areas or directly to the weak sectors of a dangerous fire; also to return men from fires, thus making them more quickly available for other duties.

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FIGURE 11.—Helicopters are used to scout a fire, to transport men, and to deliver urgently needed supplies to fire fighters.

Helicopters can be used for fast laying of fire hose over rugged ground. The hose, carried in a large shallow tray beneath the helicopter, is strung along the ground as the aircraft moves forward. In this way 1,500 feet of hose have been laid on a steep slope in less than a minute. For quick initial attack on fires, specially trained and clothed fire fighters can jump from helicopters hovering a few feet above ground, in areas unsuitable for helicopter landings. From helicopters, water or chemicals can be dropped accurately on critical spots at the head of a fire, slowing its advance.

Mechanized Equipment

Groundwork in fire suppression is becoming increasingly mechanized. The Forest Service, State forestry departments, and forest industries are constantly working to improve their equipment and develop new items that will increase the speed and effectiveness of fire control. Regional fire-equipment development committees representing State, private, and Federal agencies help to reduce duplication of effort in testing and experiments. Equipment boards within the Forest Service also aid in coordinating effort.

Water equipment used in fire control now includes efficient backpack pumps, portable gasoline pumpers of various sizes and capacities, and large tank trucks capable of good speed on roads. By setting up a relay pumping system (a modern adaptation of the bucket brigade), water has been pumped over a mile to a forest fire more than 2,000 feet in elevation above the water source.

Among recent developments by the Forest Service is a combination toolbox and pumper-tanker for ½- to 1½-ton pickup trucks. These combination units serve during the fire season for fire suppression work, and in off-season, with pumper and hose reel removed, they can be used as a tool and supply box for other work. Much progress also has been made in standardizing tanker equipment used in fire suppression.

Performance testing of tractor-drawn fireline plows is providing comparisons of the hundreds of different plow designs, proving the best, and aiding in their standardization. As a result of the tests, manufacturers are showing increased interest in producing this specialized equipment.

About two-thirds of the cost of forest fire suppression is for labor; many man-hours of hard, sweating work with handtools are necessary on most fires because much fireline, especially in rough country, cannot be worked with tractor-dozers or other heavy mechanical equipment. Hence great need exists for small-sized power tools for fire fighters. In the same way that gasoline-powered chain saws have reduced the labor required for tree felling, small fireline trenching machines and brush and sapling cutters can aid in fire suppression. The Forest Service has made progress in developing a suitable motorized fireline trencher. Commercial manufacturers have cooperated with the Forest Service in the development of gasoline-engine-powered brush and sapling cutters for forest fire suppression work.

The Forest Service has special camp equipment for feeding, "sleeping," and otherwise caring for fire fighters. During a fire emergency, temporary camps must be set up quickly for dozens, and sometimes hundreds or thousands, of men. Compact camp cooking and other

outfits designed for 10-man, 25-man, or larger camps are kept ready packed to go out on a moment's notice. The fire-camp equipment is constantly being modernized and made more efficient. Disposable paper and plastic dishes and utensils are now replacing tinware. Camp kitchen crews and equipment needs are being reduced through use of precooked or frozen foods, or delivery (sometimes by air) of ready-to-eat hot meals. Disposable paper sleeping bags, now being developed in cooperation with the paper industry, may save a large part of the costs of cleaning blankets and sleeping bags. Combination unit packaging of food and mess equipment and its delivery to the fireline by parachute or helicopter reduces the time consumed by fire fighters traveling between fireline and camp.

Communications

Speedy and reliable communications are one of the keys to successful forest fire suppression. Both telephone and radio systems have a part in the communications networks on the national forests. Primary fire-detection stations are usually connected with headquarters stations by telephone lines, and many of them also act as radio relay or communication stations for contact with outlying stations and camps. Portable, mobile, and field radios are used by smokechasers and field crews for quickly setting up communications on fires (fig. 12). As commercial telephone and powerlines extend farther out into the forest areas, the Forest Service is constantly altering and modifying its communication systems on the national forests. More radio stations and portable field radios are being acquired each year, in the process of gradually building up the radio communications systems to planned levels. A full line of equipment for use in a higher

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FIGURE 12.—Portable radios provide communication between fire crews and their headquarters.

radiofrequency band has been developed, and more channels will now be available for forestry communications.

Several State forestry agencies have long been active in developing radio communication networks, and during the past few years the use of mobile and portable radio by the States has rapidly increased. Nearly all States are now using radio in forest protection, as well as for other State services such as fish and game work and highway patrol. Special equipment is being installed in several States for intertying State and Federal forest radio networks, to provide for prompt interchange of fire-control information.

THE STATUS OF PROTECTION TODAY

National Forests

The Federal Forest Service is directly responsible for the protection of some 180 million acres of national-forest land from fire. This includes federally owned land in national forests in 39 States and Puerto Rico. In addition to the federally owned lands, the Forest Service, under agreements with the States or with individual owners, protects several million acres of intermingled private lands within the exterior boundaries of the national forests. The total area of national-forest and other land under protection of the Forest Service is approximately 222 million acres.

During the past few years, fires have burned over annually an average of about 247,000 acres of national-forest land and other protected lands inside national-forest boundaries (exclusive of Alaska). This was about one-tenth of 1 percent of the area protected. In terms of total protected area, protection could have been called highly effective. On a number of national forests, however, the losses often far exceeded this percentage (fig. 13). In one year, more than half of the total area burned was in California, where nearly 50 major fires taxed fire-fighting forces to the limit. Arizona and New Mexico national forests also

F-451595

FIGURE 13.—Dense, dry brush and strong fall winds combine to make the critical fire condition resulting in this California fire.

have had some unusually severe fire seasons, with an acreage loss one year that was 4 times greater than the preceding 5-year average.

Such heavy losses in individual national forests greatly hamper the orderly long-term management of the forest resources. In some forests, fires over a period of years have materially reduced the total volume of timber, which means that the allowable annual cut under sustained yield is likewise reduced. This cuts down employment and income in adjacent communities. Multiplied many times over in various forest management units, such losses will have an appreciable effect on the Nation's timber supply. On noncommercial forest lands, heavy burning also has far-reaching effects. Because of fires on chaparral-covered watersheds in southern California, for example, millions of dollars have been expended for flood-control works to cope with accelerated storm runoff. Elsewhere, many reservoirs holding irrigation water or municipal water supplies have lost a part of their capacity, and some have been completely filled with debris, because of siltation speeded up by fires on the watersheds.

The success of fire control, therefore, cannot be judged by overall statistics. It must be judged by the degree to which fire losses are held below the maximum that can be tolerated on each and every individual forest management unit. And it must be judged not only for one year but for a long period—the rotation period of a timber crop, for instance, which may be from 25 or 30 to more than 100 years; or the life of a reservoir, which should be as long as it will be needed.

From 1955 to 1957, the number of fires occurring each year in the national forests averaged about 8,650. The great majority of these were held to a small acreage. Ordinarily, less than 1 out of 10 got away to reach class C size (10 to 100 acres) or larger. It was these relatively few big fires that accounted for a large part of the total acreage loss. In nearly every case, these runaway fires could have been held to a small area if adequate manpower and quicker transportation facilities had been available.

The Forest Service fire-fighting forces and facilities in the national forests today can cope with the fires that break out during periods of normal or better than normal weather. But they are spread too thinly to insure against serious losses when unusually bad fire weather occurs. As a matter of sound business, considering the values at stake, the Forest Service will keep working to build a fire-control organization of sufficient strength to assure adequate protection of those values.

Other Federal Lands

Fire is a hazard, in varying degree, on many parts of the nearly 180 million acres of unappropriated and unreserved public domain land of the United States, including the 147 million acres in grazing districts established under the Taylor Grazing Act of 1934 (fig. 14). Much of this land is desert or semidesert, or range and watershed land bearing grass or brush, but about 28 million acres is classed as timber or woodland, including some 4 million acres which bears commercial timber stands. The Bureau of Land Management, Department of the Interior, which manages this public domain land, receives appropriations for fire control and maintains an organization for fire protection. Its fire problem is relatively light on large areas of desert and open range, but on some parts of the public domain, the hazard is comparable to that on adjacent national forests.

F-359800

FIGURE 14.—Range and watershed lands are damaged by fires like this.

In Alaska, there are some 265 million acres of unreserved public lands, under jurisdiction of the Bureau of Land Management. By estimate, about 125 million acres of these public lands are forest lands. Organized protection as yet has been set up on only a very small part of the public lands in the vast region. Nearly every year, fires burn unchecked over large areas in the Alaskan interior. Only about 25 million acres of heavily timbered land has not been burned. Recent sample plot studies in these unburned stands by the Forest Service's Alaska Research Center showed timber stands that compare with those of northern New Hampshire and Maine. They are worth protecting. By the practice of a little silviculture, foresters can probably increase the timber growth substantially—if fire leaves any of the present forests.

Under a 1937 act of Congress, the Bureau of Land Management also administers the Oregon and California revested lands, comprising a little over 2 million acres in western Oregon. The O & C lands bear highly valuable forests of Douglas-fir and western hemlock. Under reimbursement agreements with the Bureau of Land Management, the U. S. Forest Service and the Oregon forestry department, which have fire organizations already functioning on adjoining lands, handle fire protection on the O & C lands.

The Bureau of Indian Affairs, National Park Service, Fish and Wildlife Service, and Atomic Energy Commission handle fire protection on lands under their jurisdiction. The armed services provide protection for more than 2 million acres of forest land in Army, Navy, and Air Force reservations. The Tennessee Valley Authority arranged with various agencies for the protection of some 340,000 acres of forest land acquired in connection with its reservoirs.

State and Private Forest Lands

The State forestry agencies maintain protection organizations to combat fires on State and private forest lands. Under the Clarke-McNary Act of 1924, the Forest Service cooperates with 44 States and the Territory of Hawaii in providing this protection. Cooperative protection under the act in 1957 covered nearly 396 million acres. The total area of State and private forest and watershed land needing protection was 435 million acres, so some 39 million acres still remained without organized protection from fire.

On those lands under systematic protection, the area burned each year usually amounts to less than 1 percent of the area protected. Of the lands still lacking protection, from 10 to 15 percent burns over in an average year.

Generally the State forestry agencies and the U. S. Forest Service organize protection along similar lines and use the same types of equipment and fire-fighting techniques. State agencies have increased the effectiveness of their protection markedly in recent years. Even though the area under protection has been expanded, the total area of protected land burned has averaged less in recent years than in earlier periods.

In many areas, however, protection forces are far too meager, and present facilities are inadequate to meet the hazards of a normal season, let alone cope with the "blowup" conditions of abnormal years. State forestry agencies as well as Federal agencies are faced with higher wage rates and increased costs of equipment. Their costs of forest protection have gone up a great deal since World War II.

Fire law enforcement has been given increased attention by the States during the past few years. Several thousand cases are now being prosecuted each year, with convictions obtained usually in more than 90 percent of the prosecutions. The continued large number of fires of incendiary origin, however, shows a need for further intensification of forest fire law enforcement, as well as increased effort in prevention education.

The yearly cost of providing basic protection for the 435 million acres of State and private forest land needing it was estimated in 1957 at $83,509,000. Funds expended during recent years have amounted to about $45 million a year. State and private agencies provided more than two-thirds of the total; the annual Federal contribution was less than $10 million. Although the Clarke-McNary Act contemplated that the Federal Government would meet half of the total cost of protection, the Federal contribution has never matched State and private funds.

Congress in 1949 authorized increased appropriations for Federal participation in the cooperative forest fire protection program. Increases of $2 million each year to a maximum of $20 million possible in fiscal year 1955 and each year thereafter were authorized. The actual appropriations have been about one-half the authorized amount.

Mutual Aid

The six New England States and New York have entered into a Northeastern Interstate Forest Fire Protection Compact. This interstate agreement for mutual aid was authorized by Congress in 1949 and subsequently ratified by each of the participating States. By later congressional authorization, the compacting States may join

with contiguous Provinces of Canada in an international organization to fight fires. The compact provides for mutual aid among the States in fighting forest fires and in other measures to promote effective fire prevention and control. A Northeastern Forest Fire Protection Commission has been set up to facilitate carrying out provisions of the agreement.

Interstate compacts for the Southeastern, South Central, and Middle Atlantic regions, to serve similar purposes, have also been put into operation.

The Forest Service and State agencies make available to each other their research findings and newest developments in fire-fighting equipment and techniques. Fire-control personnel of other agencies are invited to Forest Service training camps and conferences. Fire Control Notes, a quarterly journal published by the Forest Service's Division of Fire Control, serves all Federal, State, and private forest protection agencies as a clearinghouse for information on fire-control methods and equipment.

In fire-control work on the national forests, the Forest Service receives excellent cooperation from many agencies. During emergencies, the Army and Navy have furnished men and equipment to help fight a number of bad fires (fig. 15). The Air Force and Coast Guard have aided in aerial detection and scouting. In Alaska the Bureau of Land Management has furnished men and equipment and the Fish and Wildlife Service has provided aircraft to help control fires in the Chugach National Forest. The Bureau of Indian Affairs and the National Park Service cooperate in fighting fires. State forestry agencies give excellent cooperation in the joint handling of many large fires. The Weather Bureau cooperates in special spot forecasting during emergency periods. The American Red Cross has given outstanding aid on many fires.

State and Federal forestry agencies receive much fine cooperation from lumber, pulp and paper companies, and other forest-products industries, and from local communities and groups. Cattle-grazing permittees have organized for fire duty on some of the western national forests. In a number of instances, nearly every able person in towns near a forest has turned out to help during a fire emergency.

FOREST FIRE RESEARCH

Progress in all phases of fire control has always depended upon advances in understanding of fire behavior in the many varied situations throughout the country, and upon the discovery of better ways to prevent the start of fires and to fight them skillfully when they do start. Systematic fire control has been built on the results of fundamental and applied research and equipment development over the years. Studies concerning problems in fire control were among the earliest research projects undertaken by Federal and State forestry agencies. In the early days of these agencies, too, nearly every man was directly engaged at least part of the time in some phase of fire-control work. Because the problems were challenging, these men studied fires and tried new methods. Consequently, a constant flow of new ideas and rapid development of new and more efficient methods came from both research and administrative men, especially during the period 1920–40. Much of the earlier work, however, was by trial-and-

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FIGURE 15.—*Top*, Navy tanker rig doing forest fire duty; *bottom*, soldiers on the fireline.

error methods, and there was need for more correlation and for a more systematic approach in research and equipment development activities.

Forest Service activities looking to the development of new or improved fire-control equipment are now directed mainly by the Service's Division of Fire Control which maintains two equipment development centers, assigns equipment development projects to engineers and other technicians in the various national-forest regions, works with various manufacturers, and serves as a clearinghouse for the interchange of information on equipment matters among fire-control agencies. Several States have equipment development and research centers, and some of the Forest Service equipment development projects are conducted in cooperation with these State forestry agencies.

In addition to its on-the-job development work the Forest Service conducts a program of scientific study, through the regional forest experiment stations, on the more basic problems of forest fire control. To better correlate the fire-research activities underway and to develop a more effective program of research for the future, the Forest Service set up a new Division of Fire Research in 1949. Under the direction of this Division, studies are underway on the behavior of fires, on improved methods for measuring fire danger, on the visibility factors that affect fire detection both from the air and from the ground, and on numerous other problems that concern the fire-control administrators and fire fighters on the job. Certain beneficial uses of fire in the forests are also being tested. There is a modest program of highly technical research also, which is concerned with the study of fire itself.

Research has developed data on rate of spread of fire in different fuels, on the correct location of lookout points for maximum coverage, and other knowledge that aided greatly in converting fire control into a well-organized and systematic procedure based on technical plans. An important contribution has been the development of methods of measuring fire danger. Fire-danger meters have been developed in various forms to fit local conditions and are now used on all national forests and by the State protective organizations. The fire-danger meters help fire-control officers determine when men must be at their posts or alerted for duty. They also indicate the times and duration of periods of such extreme fire danger that forest areas need to be closed to the public, or other emergency measures taken.

Fire-research activities have included laboratory and field studies of the advantages and limitations of wetting agents and chemicals in forest fire fighting. They include new studies on the relation of local turbulence of the atmosphere to the erratic and whirling action that too often causes fires to escape control and become a terrible menace to lives and property. This may point the way to methods of recognizing "blowup" conditions in advance, so that more skillful fire-fighting strategy can be employed and the danger to the lives of forest fire fighters and others can be reduced.

A technique being rapidly developed is the use of tank-equipped airplanes to drop liquids on a fire or ahead of it. Up to several hundred gallons of water mixed with a wetting agent or sodium calcium borate, a fire retardant, is released in a few seconds, falling in a strip pattern because of the plane's speed. The fire is retarded or cooled enough to permit effective ground crew attack, or may be stopped entirely under favorable conditions.

Emergency fire fighting is often spectacular and its successes are impressive, but the slower and more complex task of finding ways to prevent fire emergencies from occurring eventually brings greater advances in forest protection. The most rapid progress in systematic fire control has been closely associated with the activities of fire-research men searching for ways to reduce the great odds that men face when they are pitted against the great natural forces released by runaway forest fires. During World War II fire-research activity was unavoidably reduced. It has not yet been expanded to the extent needed in solving the problem of excessive and unnecessary forest fire losses. Clearly, a strong continuing program of research aimed at reducing the amount of actual fire fighting that will have to be done, and at making the effort more effective when fire fighting must be done, is a key feature of modern-day needs.

FIRE PROTECTION IN CIVIL DEFENSE

At the request of the Federal Civil Defense Administration, the Forest Service and cooperating agencies have prepared comprehensive plans for protection of all the Nation's forest and wild lands from fire, including possible fire attacks through enemy action. The Department of the Interior and the State Foresters cooperated in the preparation of the operational phases of these fire plans. These plans, all told, cover more than a billion acres of forest and range land in the United States.

A national committee was set up to coordinate the emergency fire protection program, with representatives of the Forest Service, the State Foresters' Association, Department of the Interior, and the Federal-State cooperative forest fire protection program.

The program calls for planning and organizing forces to fight forest fires and to meet extraordinary situations that might arise in the event of a war emergency. Master wild land operational fire plans have been developed, providing for the quick mobilization of all presently available fire-fighting personnel and equipment when needed, and for the additional personnel, equipment, and facilitating gear that might be required to prevent a fire disaster or calamity from developing.

During World War II, the enemy was well aware of the damage that forest fires could do to our war effort. Early in the war, an alert Forest Service lookout man stopped a forest fire started by an enemy incendiary bomb dropped by an airplane presumably launched from a Japanese submarine off the coast of Oregon. Later, in 1945, the Japanese made a long-distance attack on the forests of the western United States with incendiary balloons. Besides the direct damage forest fires do to timber, watersheds, and property—and to human life—they can disrupt communications and transportation, tie up logging and other industrial operations, and cause a big drain on the time of workers on the farms and in the factories—time that would be much better spent at productive work, whether during a war emergency or in time of peace.

FOREST FIRE LOSSES CAN BE STOPPED

Significant progress has been made, especially during the past 20 years, in the development of effective fire-control techniques, and in extending organized protection to forest land. Wherever systematic,

organized fire control has been undertaken, a pronounced decrease in forest fire losses has resulted.

Consequently, the assignment of responsibility for forest protection and the provision for adequate facilities and equipment for prompt and effective attack on fires is the first requirement in reducing fire losses. Bringing under organized protection the 39 million acres of State and private land that still lack it is one obvious means of cutting national fire losses below present levels. Strengthening the existing protective forces is another.

But establishment of systematic protection is only the first step in protecting forest values. The protection must be backed by continued and intensified research and development work, aimed at making it more effective.

At present, in spite of notable reduction in fire losses, the progress of forest protection has not yet been sufficient to give forest values generally the degree of safety that is considered essential for other kinds of property. The existing situation varies widely, however. Possibilities of fire loss and costs of protection are much higher in some forest regions than in others. They vary widely, too, in one area as compared with another, because of differences in climate, type of forest, exposure to sources of fire, accessibility, and adequacy of the local fire-fighting organization.

Future progress will depend on effective prevention work, on providing the men and facilities necessary to do the job of controlling the fires that do start, and on an aggressive and continuing program of research and development looking to better protection at less cost. It will call for public cooperation, and careful study and planning as well as action on the fireline. It is encouraging that protection has advanced far enough in some localities, without the costs becoming excessive, so that fires are no longer a serious hazard to timber-growing enterprises or to watershed values.

Guidelines for eliminating fire as a destroyer of forests and wild lands nationwide are now well established. But there is still much to be done.

THE NEED FOR GOOD MANAGEMENT

Good protection is a first requirement in establishing good forest management. Intensive forest management cannot be practiced unless there is reasonable assurance that timber management plans will not be disrupted by fire, that young growth can be brought to maturity, and that the investment by an owner in the growing timber on his land is at least as safe from fire loss as other forms of property in which he might invest. In only a few localities are such assurances now in sight. They do not yet prevail generally in any of the important timber regions of the United States.

One of the most important justifications for protecting the forests from fire is in the protection of the future timber crop. The loss of mature, merchantable timber through forest fires is of course serious, and it is a more readily appraised loss than the loss of future productivity (fig. 16). Actually much of the mature timber killed by fires may be salvaged. Under conditions of good accessibility and intensive management, nearly all large trees can be salvaged, though some deterioration in quality of the product is inevitable.

F-422248

FIGURE 16.—No promise for the future here. Some merchantable timber may be salvaged, but the opportunity for another crop is gone with the destruction of the seedlings, young timber, and seed trees.

In 1952, a fairly normal year, fires killed 236 million cubic feet of standing timber. In terms of sawtimber—trees large enough for manufacture into lumber—the total killed by fire was 781 million board-feet. More serious were the resulting losses in future growth. Fires often destroy seedlings and young saplings; many years may elapse before another future tree crop gets started in the same area. Larger trees may survive a fire but grow more slowly afterward. For the period 1948–52, the average annual timber loss due to fire—timber killed plus loss in future growth—was slightly more than 1,800 million cubic feet. This is about equal to the wood requirements of the United States pulp and paper industry in 1952. The annual damage to sawtimber, including loss in growth, averaged about 8 billion board-feet—equivalent to one-sixth of the sawtimber cut in 1952 for useful products.

On the other hand, timber growth in America needs to be nearly doubled to meet the greater demand for timber products expected by the end of this century, largely because of the rapid expansion

of our population. Bringing about such an increase in forest production will require much more careful management of forest land than that generally practiced at present.

Along with good protection from fire, the land resources and the timber growing stock need protection from other destructive agencies such as insects, diseases, and overgrazing by livestock or game animals, before a secure basis for good forest management can be established.

Protection from fires is thus not the sole answer to the forest problem. It is necessary, by the application of positive forest management, to build up timber growing stocks, to make and keep forest lands of the United States permanently productive (fig. 17).

But full and effective protection against fire is one of the important phases of this great forestry job.

F-457028

FIGURE 17.—Timber now and for the future. These small clear-cut areas in old-growth Douglas-fir will have ample time in which to start new crops before the intervening strips of timber will be cut. Good management, including protection from fire, means the forests will keep on giving us their many benefits.

HISTORIC FOREST FIRES

Fires raging through the forests have ranked with floods, earthquakes, and tornadoes as major calamities. Some big fires that have occurred in the United States and Canada are listed below. Figures on lives lost and area burned in the earlier fires are based on fragmentary and often conflicting accounts. In any event, the statistics tell only part of the story. For sheer loss of human life, the Peshtigo fire in 1871 rates as one of the worst disasters our country has ever known. Entire towns and communities were destroyed. Five times as many people were killed as in the great Chicago fire which began the same day.

The Cloquet fire in 1918 gutted and left in ashes the community of Cloquet, Minn., a thriving town of 12,000 people. The Tillamook fire in 1933 killed 12 billion board-feet of high-quality timber, and the loss to labor, industry, and the public was estimated at $350 million. In the Maine fires of 1947, hospitals, schools, churches, hotels, homes, farms, and businesses were wiped out. The Red Cross alone spent $2,357,000 for relief and rehabilitation. Damage to timber and property ran into millions.

Name of fire	*Date*	*Location*	*Acres burned*	*Lives lost*
Miramichi	1825 (October)	Maine and New Brunswick	3,000,000	160
Seboeis	1837	Maine	130,000	-----
Yaquina	1846	Oregon	450,000	-----
Pontiac	1853 (May)	Quebec	1,600,000	-----
Nestucca	1860	Oregon	320,000	-----
Silverton	1865	----do	1,000,000	-----
Coos	1868 (September)	----do	300,000	-----
St. Helen	1868 (September)	Washington and Oregon	300,000	-----
Peshtigo	1871 (October)	Wisconsin	1,280,000	1,500
Michigan fires	1871 (October)	Michigan	2,000,000	-----
Big Horn	1876	Wyoming	500,000	-----
Bagot	1880 (September)	Quebec	288,000	-----
Michigan	1881 (September)	Michigan	1,000,000	138
Comstock	1891 (May)	Wisconsin	64,000	-----
Phillips	1894 (July)	----do	100,000	13
Hinckley	1894 (September)	Minnesota	160,000	418
Columbia	1902 (September)	Oregon and Washington	604,000	18
Adirondack	1903 (April–June)	New York	450,000	-----
Fernie	1908 (August)	British Columbia	64,000	9
Chisholm	1908 (September)	Minnesota	20,000	-----
Great Idaho	1910 (August)	Idaho and Montana	2,000,000	85
Baudette	1910 (October)	Minnesota and Ontario	300,000	42
Cloquet	1918 (October)	Minnesota	-----	[1] 400
Matilja Canyon	1932 (September)	California	220,000	-----
Tillamook	1933 (August)	Oregon	267,000	1
Maine fires	1947 (October)	Maine	200,000	16
Texas fires	1947 (October)	Texas	55,000	-----
California fires	1955 (Aug.–Sept.)	California	307,000	1

[1] Including other fires in the same region.

U. S. GOVERNMENT PRINTING OFFICE: 1958

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